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SCIENCE IN THE HIGH SCHOOL

A Review of Science Teaching in the High Schools of North Carolina for 1920-1921

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THE ORGANIZATION of science courses in the high school is one of the most difficult problems with which thoughtful superintendents have to deal. Should general science supplant physical geography as an introductory science? If so should physical geography be taught? What other sciences should be taught and in what sequence? What methods should be used? The purpose of this article is not to answer these questions directly, but rather to furnish descriptive information about the organization and teaching of the sciences in the larger city schools of North Carolina.

To secure this information a set of questions on each of the following sciences was prepared: General science, physical geography, biology, chemistry, and physics. In preparing the questionnaire an attempt was made to include questions so worded and arranged that, if they were answered fully, it would furnish information covering more or less fully the following points: First, what science courses are taught; second, what the equipment is as to teaching personnel; third, what methods are used and what ideas are kept in mind in teaching the courses; fourth, how much and what kind of laboratory work is done; fifth, what amount of laboratory equipment is available? Mimeographed copies of the questionnaire were made, and a copy was mailed to each of the heads of the science departments in the twenty-seven North Carolina cities with five thousand or more inhabitants. In the course of three months nineteen of the twenty-seven questionnaires were returned with the desired information. The information was then arranged in five separate tables.

In Table I the first, second, third, and fourth year science courses in each of the cities which returned the questionnaire are shown. General science is the first year science in all of the schools except one, the first year science in this case being physical geography.

TABLE I

Courses in Science Given	Asheville	Burlington	Chapel Hill	Charlotte	Concord	Durham	Fayetteville	Goldsboro	Greensboro	Greenville	Henderson	Kinston	New Bern	Raleigh	Rocky Mount	Salisbury	Washington	Wilmington	Wilson	Winston-Salem
First Year Gs--Gen'l Sc.	GS	GS	GS	PG	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS	GS
Second Year B—Biology PG—Phys. Geo.	B	B	PG	B	PG	B	PG		B	B	B	PG	B	B	B	PG	B			B
Third Year C—Chemistry BY—Botany	C			C	P			C	C		C	B	C	C	C		C		BY	C
Fourth Year P—Physics	P		P	P			P	P	P	P	P	P	P	P	P	P	P	P	P	P
Total Years Science	4	2	3	4	3	2	3	3	4	3	4	4	4	4	4	3	4	2	3	4
Pop. in M	28	5		46	9	21	8	11	19	5	5	6	12	24	12	13	6	33	10	48

In the second year biology is taught in twelve schools and physical geography in four. Three schools offer no science in the second year.

Chemistry is offered in ten schools as the third year science. Physics is offered in one school; biology in one, and botany in one. Seven schools offer no third year science.

As a fourth year science, physics is offered in six-

teen out of the nineteen schools. Counting the school which offers physics in the third year, the number of schools offering physics is only one less than the number offering general science. Three schools offer no fourth year science.

There are ten schools giving four years of science, seven giving three, and three schools giving two years of science.

Coming now to a somewhat detailed discussion of the separate sciences and taking up general science first, (Table II) the question immediately arises, is the course a text-book course, a question and answer course, or is the laboratory method used? In science teaching this is one of the most important questions. By studying the table for general science it is discovered that the time devoted to laboratory work varies from naught hours a week to one and two-thirds hours a week. Of the eighteen schools, eight use one and two-thirds hours a week in laboratory work; one gives one and one-third hours to laboratory work; five give forty-five minutes to laboratory work, and three give none.

The way in which these laboratory periods are used, the nature of the laboratory work, is a very critical point. We approach the ideal situation in laboratory work as conditions become such that the student's work is individual. It is observed in column two that in two schools the ideal situation is approached, in that the laboratory work is performed by the students working individually and in groups. Demonstration experiments may be used on class but are not counted as a regular laboratory exercise. In six schools the laboratory work consists of individual work by the students and demonstration experiments performed by the teacher. In seven schools the laboratory work consists entirely of demonstration exercises performed by the teacher. In three schools the course is entirely a text-book course.

TABLE II

Schools Teaching Gen'l Sc.	Hrs. Wk.	Lab. Wk.	Equip.	Av. on Class	Total	Exclus. Tchr.	Project Mthd. Used
Asheville	1⅔	Indv. Dems.	$50	27	?	Yes	No
Burlington				24	48	No	In Part
Chapel Hill	1⅔	Indv. Dems.	$100	15	15	No	In Part
Concord				35	105	No	Slightly
Durham	1⅔	Ind & Gp. Wrk.	$1200	21	84	Yes	Yes
Fayetteville	¾	Dems.	Phys. Lab. Used	40	120	Yes	
Goldsboro	1⅔	Indv. Dems.	$50	25	80	No	Yes
Greensboro	1⅔	Indv. & Gp. Wrk.	$300	28	270	Yes	Entirely
Henderson	¾	Dems. & Home X	Chem. Lab. Used	14	14	No	
Kinston	¾	Dems.	Phys. Lab. Used	30	60	No	Some
New Bern				22	43	No	No
Raleigh	?	Dems.	$200	35	200	Yes	Yes
Rocky Mount	1⅔	Dems.	$100	28	28	No	Slightly
Salisbury	1⅔	Dems.	Phys. Lab. Used	30	120	No	Some
Washington	¾	Dems.	?	30	60	No	
Wilmington	¾	Dems.	$50	37	?	Yes	No
Wilson	1⅓	Indv. Dems.	$215	25	110	No	Yes
Winston-Salem	1⅔	Indv. Dems.	$200	40	200	Yes	Yes

Given the choice between an excellent teacher with no laboratory equipment and a mediocre or poor teacher with elaborate equipment, I should choose the former for the eighth grade student. But *actually* some schools have excellent teachers and some mediocre ones. Now good laboratory equipment increases the mediocre teacher's efficiency in an arithmetical ratio and increases the excellent teacher's efficiency in a geometrical ratio. As seen in column three the value of the laboratory equipment varies from zero to twelve hundred dollars. One school has twelve hundred dollars worth of general science equipment, the next highest figure being three hundred. Four schools have about two hundred dollars invested in equipment and four schools have about fifty dollars invested in equipment. Three

schools use the physics laboratory and equipment and one school uses the chemistry laboratory and equipment. Three schools have no laboratory equipment and do no laboratory work.

The average number of students a teacher has on class is a fact of considerable importance which can be represented by figures. The significance of this is seen most clearly when an attempt is made to idealize the relation between teacher and students. The class should be a center in which is focused the work done in the laboratory, on field trips and excursions, at home, and in the library. Occasional questions by the teacher and answers by the students should give place to lively class discussions in which each student takes an active part in contributing to and organizing the information dealt with. In such discussions the teacher's function should be to direct, stimulate and advise. It is almost impossible to conduct a large class on the lines suggested above. The size of the classes in general science as seen in column five varies from fourteen to forty. There are eight schools with classes averaging thirty or more students and ten schools with averages less than thirty. Two schools have less than twenty students on class; eight between twenty and twenty-nine; six between thirty and thirty-nine; and two schools have forty students on class.

The project method has recently become very popular in some schools in teaching science, especially general science. One school uses this method entirely. Eleven others use it slightly or considerably, three do not use it, and three schools gave no answer.

It seems from the results obtained in the questionnaire that the project method is not thoroughly understood. "A project is any projected or proposed activity or experience which an individual proposes to enter upon or carry through to the end." To illustrate: The project may be to rid a community of mosquitoes or house-flies or to make an electric motor. It may be a small piece of work lasting a few minutes or it may be a prolonged piece of work lasting for weeks.

The project method, though the phrase expresses a more or less hazy idea, is an emancipation from the stilted class room methods formerly used in almost all and still employed in many of our schools.

Other methods are used but cannot be dealt with here.

TABLE III

Schools Teaching Biology	Lab. Hrs.	Nature of Lab. Wk.	Field Trips	Value of Equipmt.	No. of Micrs.	How Sub. Approach.	Av. on Class	Total Enrol.
Asheville	3	Study of Material Discussed on Cl.	No	$2,000	11	Plants; Animals	23	
Burlington	0		No		1		32	64
Charlotte	1	Field Study of Pls. & Insects; Str. & Wk. of Pls.; Str. Fr.	Yes (12) 1920-21	$450	2	As in Hunter's Civ. Biol.	40	200
Durham	3⅓	Exps. & Research on Cl. Problems	Yes	$1,400	?	As in Hunter's Civ. Biol.	15	73
Greensboro	1½	Pl. & Animal Dissect (Beans, Insects) Human Biology	Yes (8) 1920-21	$250	1	Pls. & Ans. Separate	26	103
Henderson	0	Pls. in Field	Yes (8) 1920	$0		Plants; Animals	10	10
Kinston	½	Pls. & Ans. Dissect. & Drawn	Yes	0		Civ. Biol. Fall; Practical Spr.	20	20
New Bern	1⅓	Dissect. of Insects Bact. Etc.; Plant & Animal Relations	Yes (2) 1920-1	$350	1	Pls. Rel. to Ans.; to Man; Human Phys.	23	47
Raleigh	3	Individual Work and Fiseld Trips	Yes	$1,000	9	Pls.; Ans.; Sys. Bot.; Field Wk.	23	70
Rocky Mount	0	Demonstration Exps. by Teacher	No	$50	1	Pls. Fall; Ans. Spr. (Mainly)	26	80
Washington	0		No	$0			?	50
Wilson (Botany)	1⅓	Mostly Demonstr. by Teacher	Yes (14) 1920-1	$100	2		20	40
Winston-Salem	1⅙	Exs. in Hunter's Manual; Demonstr. and Indiv. Work	Yes	$300	3	As in Hunter's Civ. Biol.	30	?

Biology

Table III shows similar data for biology. Out of the nineteen schools returning the questionnaires twelve give a course in biology and one gives a course in botany.

Of all high school science subjects it seems that good laboratory work could be done in biology most easily and conveniently with a minimum amount of equipment. North Carolina is second to no state in the richness and variety of her *fauna* and *flora*. And due to the fact that most of our cities are relatively small this laboratory, alive with plants and animals, is easily and quickly accessible to almost any high school class.

As seen in column one the time given to laboratory work in biology varies from zero hours to three and one-half hours a week. One school gives three and one-half hours a week to laboratory work; two give three; one gives one and a half; two give one and one-third; one gives one and one-sixth; one gives one hour; and one gives one-half hour to laboratory work; three give no laboratory work.

The value of laboratory equipment varies from nothing to two thousand dollars. Three schools have one thousand dollars or more invested in equipment, and only three schools give the course in biology without any equipment. One school has eleven compound microscopes, one has nine, one three, two have two, and four have one microscope.

The nature of the laboratory work, a faint idea of which may be had by observing column two, is very diverse. In the first school the laboratory work runs parallel to the class work and consists of a study of material discussed on class; plant and animal types are taken up separately and systematically. In the third school the laboratory work runs parallel with the class work. The problem-project method is used. In the next school the laboratory work is run partly separately from the class work. In the laboratory plants and animals are studied separately. A few laboratory types are taken up and studied thoroughly. The bean is used as a plant type; the rabbit as an animal type. Insects and bacteria are also studied. In two of the schools the laboratory work consists mainly of demonstration work by the teacher.

All of the schools except four use field trips in connection with the laboratory work. Two of the schools make a field study of plants and animals the main part of the laboratory work.

Space does not permit a detailed discussion of the various ways in which the laboratory work in biology is organized or should be organized. It would be worth while, however, to consider briefly the point of view or aim of the biology course. In the first school the point of view is stated as follows: "We aim to teach fundamental physiology and structure (as related to function) of common forms chiefly such as contribute to evolutionary history or are very common in the environment of pupils. In so doing we hope to instill an appreciation of plants and animals. The economic aspect is considered whenever important, and is stressed in bacteria, fungi, and disease producing and carrying animals. At the conclusion of animal forms about six weeks is devoted to human physiology." In the fourth school the point of view is

Table IV

Schools Teaching Chemistry	Exclus. Tchr.	Total	Av. in Lab.	Lab. Hrs.	Wk. Indiv. or in Prs. or Demstr.	When Exps. Written Up	Lab. Fee	Value Equip.
Asheville	Yes	80	20	3	Pairs	In Lab. (Notes Never Leave Lab.)	Only Broken Parts Paid For	$3,000
Charlotte	No	45	15	2	Pairs	In Lab.	No	$1,000
Goldsboro	No	12	12	2	Groups	In Lab. and at Home	No	
Greensboro	Yes	46	15	3	Indiv.	In Lab. (Notes Never Leave Lab.)	$2 Yr.	$900
Henderson	No	11	11	50 Min.	Pairs	At Home	No	$300
New Bern	No	71	18	1⅛	Pairs or Rarely 5; Rarely Demstr.	Notes During Exp. Written Up at Home	$1 Yr.	$750
Raleigh	No	36	12	2⅔	Indiv.	In Lab. (Notes Never Leave Lab.)	No	$400
Rocky Mount	No	38	19	4	Groups of 2 or 3	In Lab.	No	$300
Washington	No	10	10	2	Groups	In Lab. and at Home	No	
Winston-Salem	No	55	15	2⅔	Indiv.	Notes During Exp. Written Up at Home	To Cover Breakage	$800

stated as follows: "The development of the power of logical thinking, the pupil's relation to life, and his civic responsibility are aims of the course. We do not lose sight of instilling an appreciation of nature or of preparing for future science work." The seventh school in the list states that the life processes are stressed considerably; and that they give much time to the civic part of biology, i. e., how man may improve his environment and the community in which he lives. Another school states the fundamental aim of the biology course as: "a study of the interrelation of plants and animals and their economic and industrial importance. The plant side is made the basis for agriculture, horticulture, and forestry and the animal side is made a basis for human physiology. Nature study is not the main purpose of the course."

In spite of the fact that no hard and fast rules should be made regulating the content or purpose of a biology course there are certain central ideas which should be kept in mind:

1. The interrelation of the animate and inanimate world.
2. How plants and animals are fitted to nourish themselves, grow, and reproduce.
3. The unity and kinship of plant life and the unity and kinship of animal life and the interrelation between the two.
4. The power of man to control the habits and relationships of plants and animals to serve his own ends.

The opportunity should not be lost to enlarge the student's interest in life by acquainting him with his plant and animal neighbors. This part of a high school biology course, if properly handled, would be of much lasting benefit and pleasure to the students.

Chemistry

Chemistry is taught in ten of the nineteen schools returning the questionnaire. The first of these schools, Asheville, has proposed to introduce a short course in qualitative analysis to meet the needs of students who become particularly interested in chemistry.

It will be observed in column one that two of these ten schools have an exclusive teacher for chemistry. The teacher in the first of these two schools has eighty students, while the teacher in the second has forty-six chemistry students. The eight remaining schools do not have an exclusive chemistry teacher. In one school chemistry and physics are taught by one teacher. In another school one teacher teaches chemistry and biology. In the other six schools the chemistry teacher may also be a mathematics, history, or language teacher. Where the classes are small and the teacher is endowed with unusual natural ability, energy, and unflagging enthusiasm and in addition has had college training in chemistry, this last combination may be fairly successful. In the vast majority of cases, however, where one teacher attempts to handle two unrelated subjects such as chemistry and history, one or the other is quite liable to be a complete farce. The ideal chemistry teacher knows more about chemistry, is more interested in chemistry, and is continuing to learn more about chemistry than any other subject. Chemistry had better be left untaught than taught by an unqualified teacher.

Table V

Schools Teaching Physics	Exclus. Tchr.	Lab. Hrs.	Total	Av. in Lab.	Wk. Indiv, or in Prs. or Demstr.	Val. Equip.	Time (in Wks.) Given to				
							Mechans.	Heat	Snd.	Lgt.	Ele. Mag.
Asheville	No	3	25	12-13	Pairs	$3,000	5	4	3	5	8
Charlotte	No	3	38	19	Pairs	$1,000					
Concord	No						12	6	4	4	8
Fayetteville	No	¾	16	16	Indiv.	$150					
Goldsboro	No	2	40	20	Pairs	$200					
Greensboro	Yes	3	43	15	Indiv.	$500	10	8	4	4	10
Henderson		0	8								
Kinston	No		10	10	Demonstr. by Teacher	$50	8	8	8	1	8
New Bern	No	2			Pairs	$350					
Raleigh	No	2⅔	18	?	Pairs (Notes) Independently	$500					
Rocky Mount	No	4	11	11	Groups	$300	12	4	4	4	8
Salisbury	No	3	16	16	Indiv. & Pairs	$1,000	15	6	2	5	8
Washington	No	2	15	15	Groups		8	6	4	6	8
Wilmington	Yes	0	60			$50					
Wilson	No	1⅓	25	25	Demonstr. by Teachers (Notes)	$725	6	2	2	2	6
Winston-Salem	No	?	20	20	Demonstr. by Teacher		8	8	8	8	1

The average number of students in the laboratory varies from ten to twenty. The time given to laboratory work runs from fifty minutes in one school to four hours a week in another. Two schools have three hour laboratory periods; five have two to three hour laboratory periods; and one school has one and a third hours of laboratory work.

In three schools the work in the laboratory is done individually by the students, in three schools the work is done in pairs, and in the four remaining schools the work is done in pairs, or small groups or is rarely performed as a demonstration experiment by the teacher.

In five of the schools the teachers require the pupils to write up the notes in the laboratory; in the other five schools the notes may be written up in the laboratory and at home.

Two schools charge a laboratory fee and two require broken articles to be paid for as broken; the six other schools charge no laboratory fee.

The value of the laboratory equipment varies from naught in two schools to three thousand dollars in one school. Four schools have between seven hundred and fifty and one thousand dollars invested in equipment and three schools have equipment valued from three to four hundred dollars.

Physics

Sixteen of the nineteen schools returning the questionnaire teach physics and two have an exclusive teacher for the subject as is shown in Table V.

Six schools either give no laboratory work or, as is the case in three schools, the laboratory work is done by the teacher as demonstration experiments. One school has a forty-five minute laboratory period, another has an hour and twenty minute laboratory period, and all the remaining nine schools give two to four hours weekly to laboratory work.

In schools where individual or group laboratory work is done by the students the average number in the laboratory sections varies from nine to twenty. In two schools the laboratory work is done by the pupils individually. In six schools the laboratory work is done by the students working in pairs and in two schools the work is done in groups.

Four schools have no laboratory equipment. One has three thousand dollars worth; two have one thousand dollars worth; one has seven hundred and twenty-five; two have five hundred; and the remaining six schools have laboratory equipment valued from three hundred and fifty down to fifty dollars.

The time in weeks given to mechanics, heat, sound, light, and electricity is shown in the last five columns of Table V.

Conclusion

A few of the general conclusions which may be drawn from the study are:

General science and physics, judging from the number of schools teaching these subjects, are the most popular high school science courses; biology comes next and chemistry last. Physical geography is rapidly being supplanted by general science though a few schools are still retaining physical geography in their curriculum.

Judging from the size of the classes and the character of the laboratory work done, more and better equipped teachers are needed to teach physics and general science.

The laboratory equipment in the majority of cases is good.

Several schools are attempting to give four full years of science when two years, well taught, would be much better.

TRANSPORTATION OF PUPILS IN PITT COUNTY, N.C.

ALL SCHOOL trucks in Pitt County are the property of the Board of Education. No district funds of any type are invested in them. We find that this plan gives us a decided advantage over that of allowing the district to buy its own trucks.

"At the beginning of the school year the principals of our consolidated schools were called together and furnished a supply of order forms of the type enclosed, and also a supply of monthly reports, copies of which are attached. An effort was made to impress upon them the very great necessity of exercising the proper care in the operation of trucks under their control. They were advised in no uncertain terms that the successful and economical operation of these trucks was considered a very definite part of their work. Should the trucks not receive the proper care, or should the cost of operation prove excessive, they would not be considered for position in our schools for next year. With this as a basis, we then began the transportation of pupils. Student drivers were employed. A few of these received no pay whatever. Several were paid $5 per month, and a number received as much as $10 per month. This was the maximum salary allowed. Each driver was charged with the responsibility of seeing that his truck was kept in proper condition. One local garage at each consolidated school was designated as a supply and repair

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